G01R 29/26

(12) UK Patent Application (19) GB (11) 2 179 458 (13) A

(43) Application published 4 Mar 1987

(21) Application No 8521184

(22) Date of filing 23 Aug 1985

(51) INT CL⁴
G01R 29/26

(52) Domestic classification (Edition I):
G1U BH BV6J
U1S 1912 G1U

(56) Documents cited
None

(58) Field of search
G1U
Selected US specifications from IPC sub-class G01R

(71) Applicant
Ferranti plc

(Incorporated in United Kingdom)

Bridge House, Park Road, Gatley, Cheadle, Cheshire SK8 4HZ

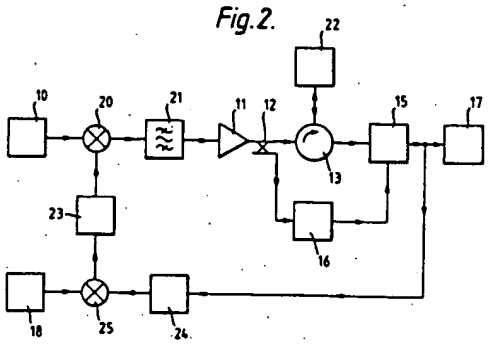
(72) Inventors
Hugh McPherson
Jeffrey Stoker

(74) Agent and/or Address for Service
A R Cooper,
Patents & Legal Department, Ferranti plc, Bridge House, Park Road, Gatley, Cheadle, Cheshire SK8 4HZ

(54) Microwave noise measuring apparatus

(57) Apparatus for measuring the phase noise content of a microwave signal source (10) includes a microwave cavity (22) resonant at a fixed frequency, signal generating means (23) operable to generate a frequency representing the difference between the source frequency and that of the resonant cavity, and mixing means (20) for combining the outputs of the source and the signal generating means. The output from the resonant cavity 22 is applied to a phase detector (15) together with a portion of the output of the mixing means (20) in phase quadrature therewith (16) and the output of the phase detector (15) represents the phase noise content of the output of the microwave source (10). The signal generating means (23) includes a voltage-controlled oscillator the frequency of which is controlled by an output from the phase detector means (15) so as to maintain the output of the mixing means (20) at the resonant frequency of the microwave cavity (22).

Fig.2.



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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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Fig.1.

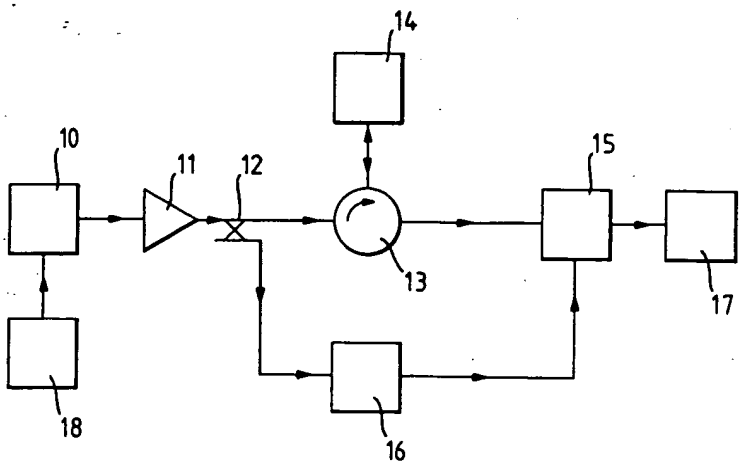


Fig.2.

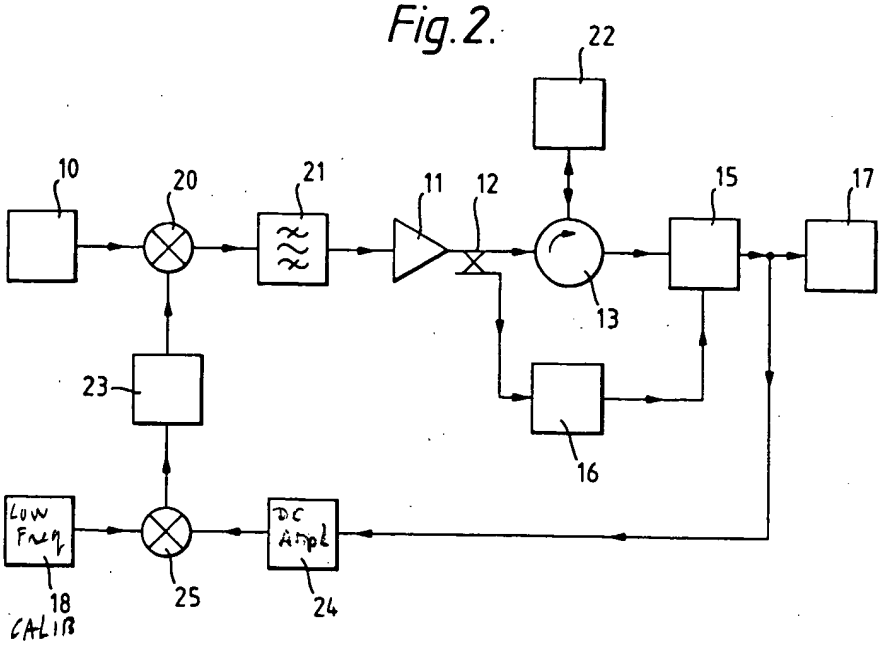
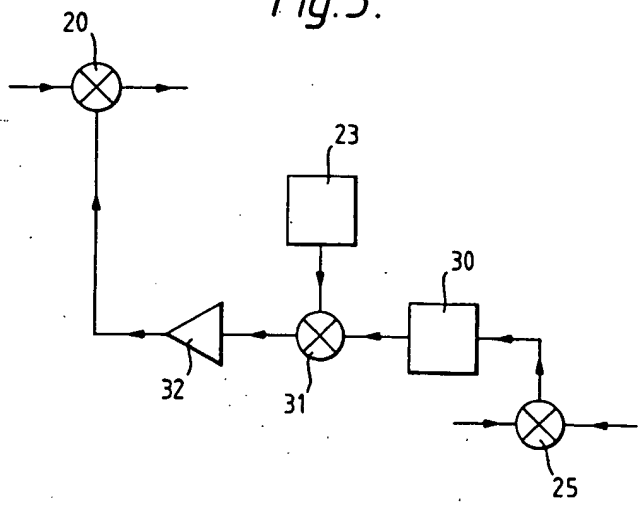


Fig.3.



SPECIFICATION

Microwave noise measuring apparatus

This invention relates to microwave noise measuring apparatus intended particularly for the measurement of the phase noise content of a microwave signal source.

All microwave signal sources generate unwanted phase noise, that is noise in the form of random frequency variations about the source output frequency. Whilst the magnitude of the phase noise content of a signal may be small it may become significant, for example in doppler frequency radar systems. This is because the radar return applied to a doppler radar receiver may be very small and is in the form of a small change in frequency from that of the transmitted radar signal. It will be appreciated therefore that phase noise could lead to erroneous interpretations of doppler signals or mask them altogether.

In order to control or reduce the phase noise content of the output of a microwave signal source it is first necessary to be able to measure the phase noise. Several techniques are known for this, but these have disadvantages which affect their use and accuracy. The techniques described relate to single-frequency microwave sources of the type which may be tunable over only a few tens of MHz.

One technique involves cross-correlation between two microwave sources, one being the source under test and the other being a reference. The main problem with this technique is the difficulty of obtaining a reference source which is of significantly better performance than the source under test. As a result a reference source may not be available, and this technique is therefore of no use.

Other techniques exist which use only the source under test. One makes use of a delay line to which the output of the source is applied and a phase detector comparing the output of the delay line with the source output 90° out of phase with it. The delay line transforms frequency fluctuations into phase fluctuations and the phase detector converts these into voltage fluctuations at its output. Unfortunately such a system has low sensitivity due to the limited amount of input power which can be applied to the system.

A second technique which avoids this problem uses a tunable cavity resonator to provide a delay in place of the delay line. The cavity is tuned to the frequency of the signal source and has the effect of suppressing the source frequency whilst leaving the noise frequency signals. This enables greater power to be applied to the measuring system, thus increasing the sensitivity. The problems which arise from the use of this technique are associated with the use of a tunable resonant cavity. Firstly the cavity has to be returned for each source frequency, and this takes time. In addition the resonant frequency of the cavity may well be sensitive to mechanical vibration. Finally, all other components in the measuring system must have wide bandwidths to cover the tuning range which the system may have to cover.

It is an object of the present invention to provide apparatus for measuring the phase noise content of the output of a microwave signal source which requires only a single microwave source and which does not suffer from the problems set out above.

According to the present invention there is provided apparatus for measuring the phase noise content of the output of a microwave signal source, which includes a microwave cavity resonant at a fixed frequency differing from that of the source by between 1% and 10% of the cavity resonant frequency, signal generating means operable to generate a signal representing the difference between the frequency generated by the microwave signal source and the resonant frequency of the cavity, mixing means operable to combine the outputs of the microwave signal source and of the signal generating means to provide a signal having a frequency equal to the resonant frequency of the cavity for application thereto, and phase detector means responsive to an output from the cavity and to an output from the mixing means in phase quadrature therewith to provide a signal representing the phase noise content of the output of the microwave signal source.

The invention will now be described with reference to the accompanying drawings, in which:–

Figure 1 shows a block diagram of known apparatus using a tunable resonant cavity;

Figure 2 is a block diagram of a first embodiment of the invention; and

Figure 3 shows a modification to the apparatus of Fig. 2.

Referring now to Fig. 1 a known phase noise measuring system includes the source under test 10 which applies a signal by way of a low noise amplifier 11, a 10dB coupler 12 and a circulator 13 to a tunable resonant cavity 14. An output from the cavity 14 passes via the circulator 13 to a phase detector 15. The signal applied to the 10dB coupler 12 is also applied by way of a phase shifter 16 to the phase detector 15, the phase shifter being arranged so that its output is 90° out of phase with the output of the resonant cavity. The output of the phase detector 15 is the output of the phase noise measuring system and may, for example, be applied to a spectrum analyser 17. The analyser is particularly useful if the source under test is frequency modulated by a low frequency oscillator 18.

In use, the resonant cavity 14 has to be tuned to the frequency of the source under test. The effect of the tuned cavity 14, so far as signals within the cavity bandwidth are

CLAIMS

1. Apparatus for measuring the phase noise content of the output of a microwave signal source, which includes a microwave cavity resonant at a fixed frequency differing from that of the source by between 1% and 10% of the cavity resonant frequency, signal generating means operable to generate a signal representing the difference between the frequency generated by the microwave signal source and the resonant frequency of the cavity, mixing means operable to combine the outputs of the microwave signal source and of the signal generating means to provide a signal having a frequency equal to the resonant frequency of the cavity for application thereto, and phase detector means responsive to an output from the cavity and to an output from the mixing means in phase quadrature therewith to provide a signal representing the phase noise content of the output of the microwave signal source.

2. Apparatus as claimed in Claim 1 in which the signal generating means comprise a variable-frequency oscillator the frequency of which is controlled by an output from the phase detector means so as to maintain the output of the mixing means at the resonant frequency of the microwave cavity.

3. Apparatus as claimed in Claim 1 in which the signal generating means comprise a fixed frequency oscillator, a voltage-controlled oscillator and second mixing means for combining the outputs of the fixed frequency and voltage controlled oscillation of the voltage-controlled oscillator being controlled by an output from the phase detector means so as to maintain the output of the mixing means at the resonant frequency of the microwave cavity.

4. Apparatus as claimed in either of Claims 2 or 3 in which the output of the phase detecting means is applied to the voltage-controlled oscillator by way of further mixing means to which may be applied the output of a low frequency calibration oscillator.

5. Apparatus as claimed in any one of the preceding claims which includes a band-pass filter connected between the mixing means and the microwave cavity and phase-shifting means.

6. Apparatus for measuring the phase noise content of the output of a microwave signal source substantially as herein described with reference to Figs. 2 and 3 of the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd. Dd 8817356, 1987.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.